## VI. CONCLUSION.

In conclusion, operating within 5 kHz channels, RZ SSB can handle a wide array of voice and data signals, providing high quality mobile communication and seamless interface with the telephone network.

| | |
|---|---|
| Channel Spacing | 5 kHz |
| Information Signal Bandwidth | 300 Hz - 3.4 kHz |
| Illustrative Transmittable Signals | • Voice/Encrypted Voice<br>• G3 Facsimile<br>• Voice-Band Modem<br>• Still Picture (Motion JPEG) |
| Maximum Speed Handling Capability of G3 Facsimile | 9.6 kbps |
| Maximum Data Handling Capability (Tested) | 19.2 kbps |
| Maximum Spectrum Efficiency (Digital) | 3.84 bits/Hz (=19.2 kbps/5.0 kHz) |
| Illustrative Channel Usage | FDMA(SCPC),TDD,TDMA |
| Analog Voice Quality | Superior to 12.5 kHz FM |
| Illustrative Voice Coders | Vocoder, VSELP, PSI-CELP, etc. |
| Degradations Due To Mistuned Carrier | None |
| Immunity To Fading And Interference | Strong |
| Cost Compared To Existing Equipment | Same |

Table 1: Features of RZ SSB

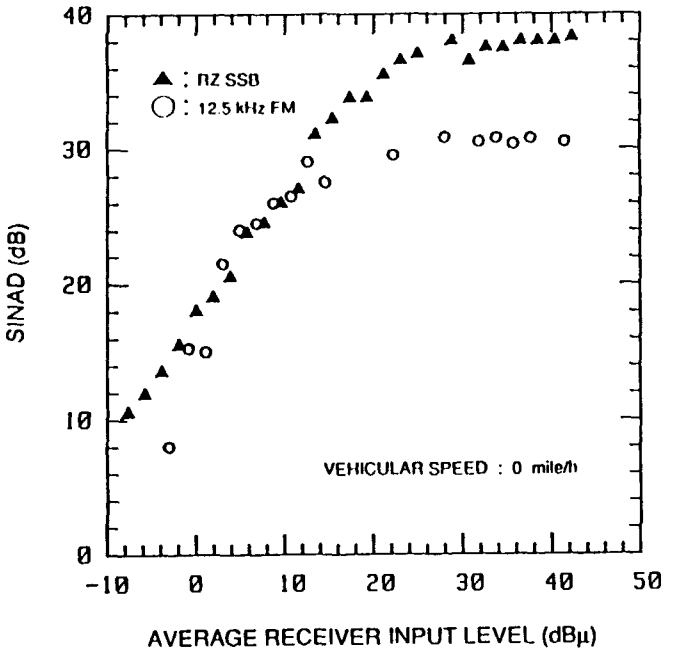


**FIG. 1 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL.**

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values using a dynamic SINAD processor. Although the speed of the van used for measurement was 0 miles per hour, vehicles around the van were moving. The RZ SSB and 12.5 kHz FM receiver were the same in noise figure values. Since the 12.5 kHz FM transmitter and receiver were originally fabricated for the Japanese cellular telephone system, their RF frequency was converted from 800 MHz to 150 MHz band. Experimental results for RZ SSB (▲) are superior to 12.5 FM (○) especially in the lower input levels.

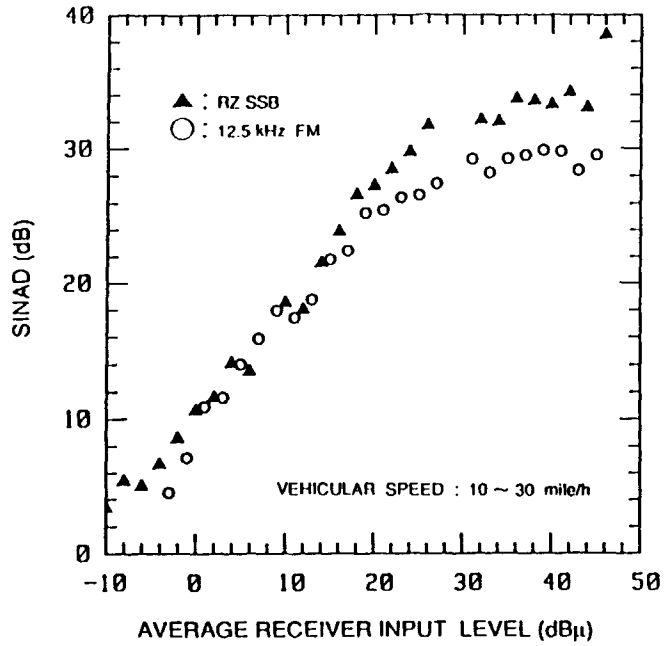


**FIG. 2 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL WITHOUT INTRODUCTION OF TWO-BRANCH DIVERSITY RECEPTION METHOD.**

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values. The speed of the van used for measurement ranged from 10 to 30 miles per hour. In this case, a diversity reception method was not introduced into both receivers. Experimental results for RZ SSB (▲) are comparable or superior to 12.5 FM (○).

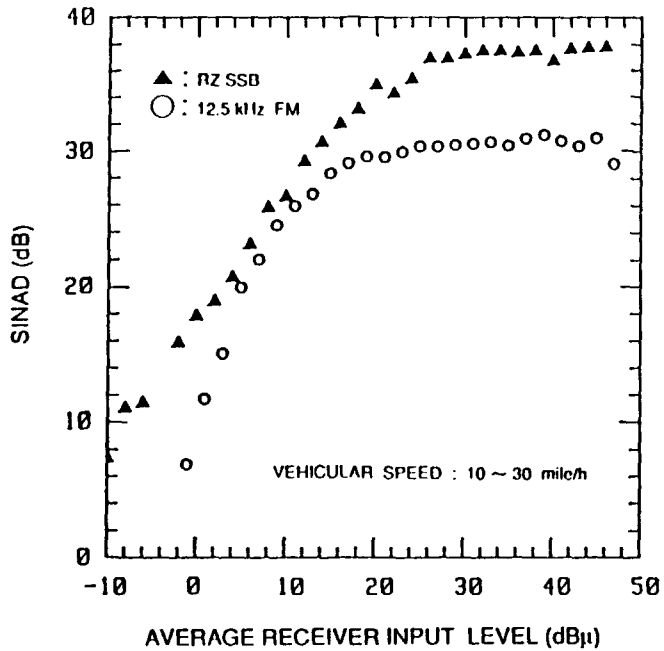


**FIG. 3 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL FOLLOWING INTRODUCTION OF TWO-BRANCH DIVERSITY RECEPTION METHOD.**

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values. The speed of the van used for measurement ranged from 10 to 30 miles per hour. The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity technique, and the 12.5 kHz FM receiver was also equipped with a two-branch selective combining diversity technique. Experimental results for RZ SSB (▲) are superior to 12.5 FM (○) in the entire region.

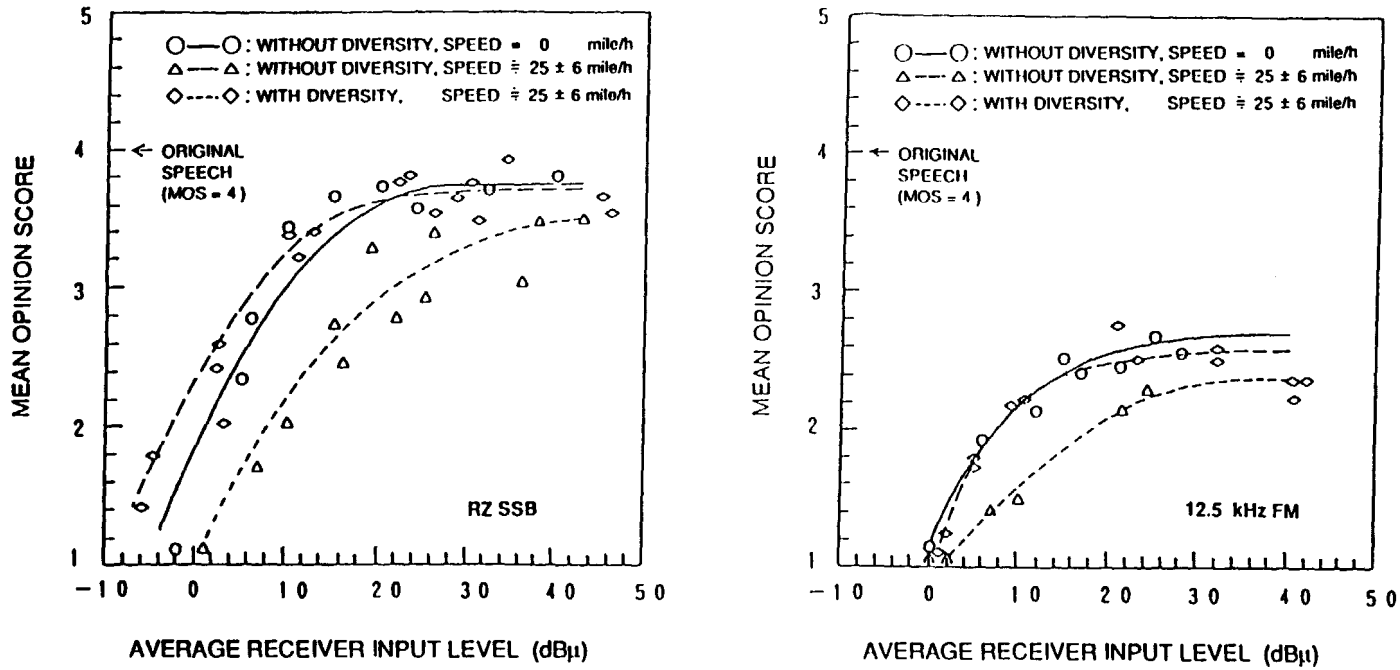


**FIG. 4 FIELD TEST RESULTS FOR SHORT SPEECH SENTENCE APPRAISED BY MOS VALUES.**

A short speech sentence (in Japanese) was appraised, as a function of average receiver input levels, by MOS (mean opinion score) values. The MOS test was conducted among approximately 20 people whose occupations are unrelated to mobile radio communications. In this test, the original speech quality was appraised as MOS = 4.0. MOS values for RZ SSB, shown on the left-hand side of the figure are superior to 12.5 kHz FM, shown on the right-hand side of the figure.

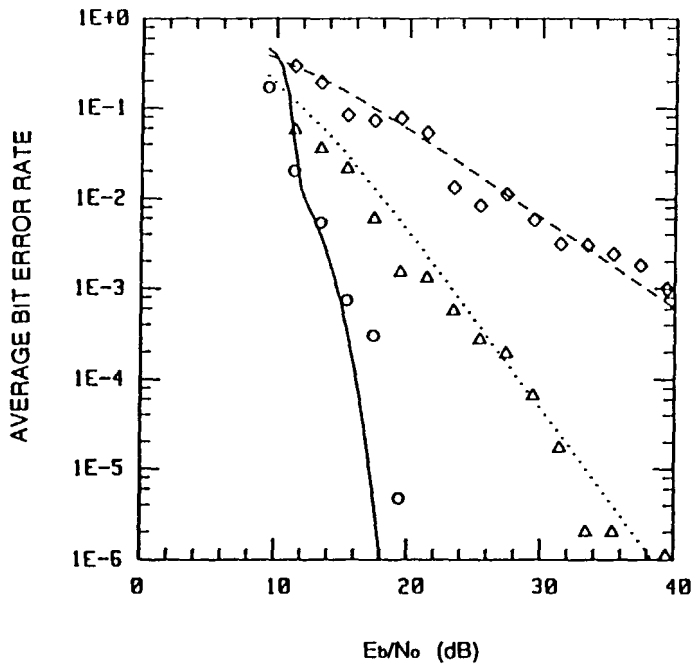


**FIG. 5 FIELD TEST RESULTS FOR VOICE-BAND MODEM SIGNAL AT 9.6 kbps.**

A 9.6 kbps voice-band MODEM signal with 16 QAM was appraised, as a function of Eb/No, by bit error rates (BERs). The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity circuit. Circles (○) denote the experimental results measured at 0 miles per hour vehicular speed. Triangles (△) and diamonds (◇) represent the experimental results using the receiver with and without diversity, respectively. During measurements, vehicular speed ranged from 10 to 30 miles per hour. The solid line (——) denotes the optimal fit curve for the indoor experimental data measured under thermal noise condition. The dotted (·····) and broken (– – –) lines are theoretically estimated curves for diversity and non-diversity, respectively. Experimental results agree well with the theoretical curves.

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Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

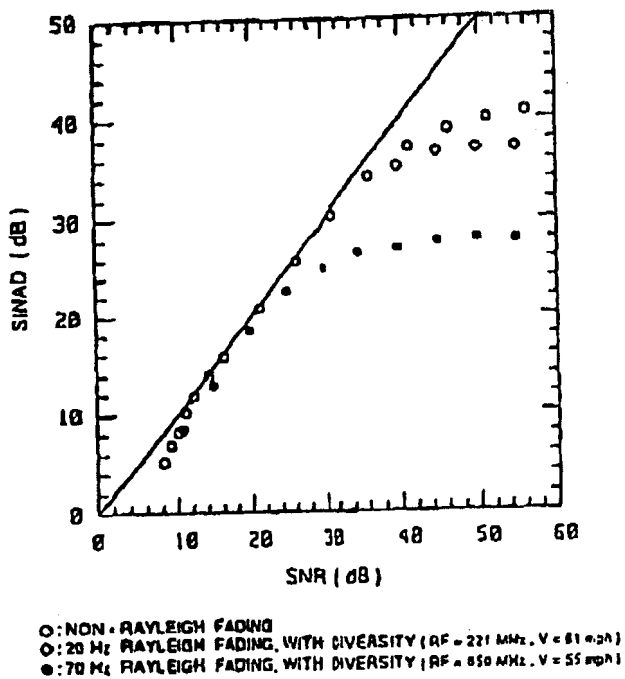
Phil.

P.J. CROSS
Group Leader - Facsimile Research

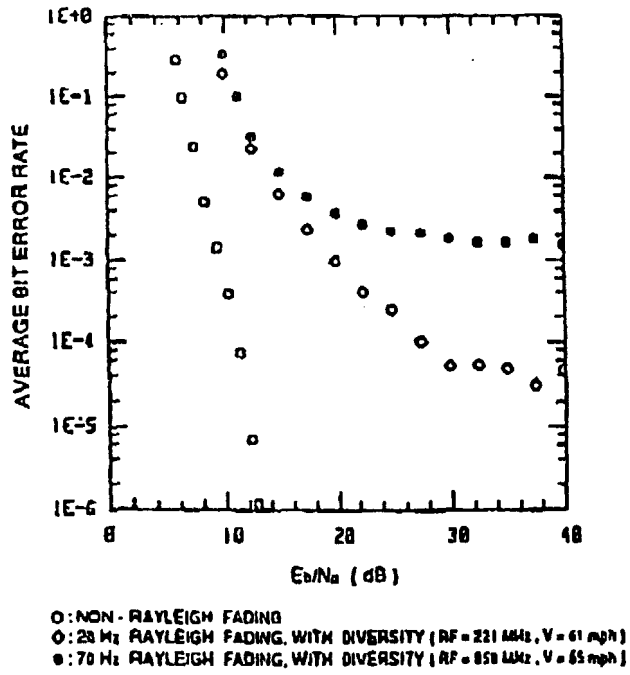
Registered in England: No. 2038
Registered Office: 60 Victoria Lane, Hard, Essex.

**FIG. 6 FIELD TEST RESULTS FOR 9.6 kbps G3 FACSIMILE SIGNAL.**

The RZ SSB receiver equipped with a two-branch equal-gain combining diversity circuit was introduced in this test. Average receiver input levels were in the vicinity of 15 dBμ or larger than 15 dBμ, where BERs less than $10^{-4}$ can be obtained for the 9.6 kbps digital signal. The 9.6 kbps G3 facsimile signal was received when the vehicular speed was between 25 and 30 miles per hour. The above copy is 70 percent of the size of the originally transmitted (normal mode) facsimile.




(a)




(b)

**FIG. 7 (a) SINAD vs. SNR for a 1 kHz tone.**
**(b) Average BER vs. Eb/No for a 9.6 kbps 16 QAM voice-band MODEM signal.**
These two experiments were conducted using a laboratory test bed system that simulated a severe land mobile radio environment by using a Rayleigh fading simulator. RZ SSB transceivers were used with a 5 kHz channel spacing in the 220 MHz band.

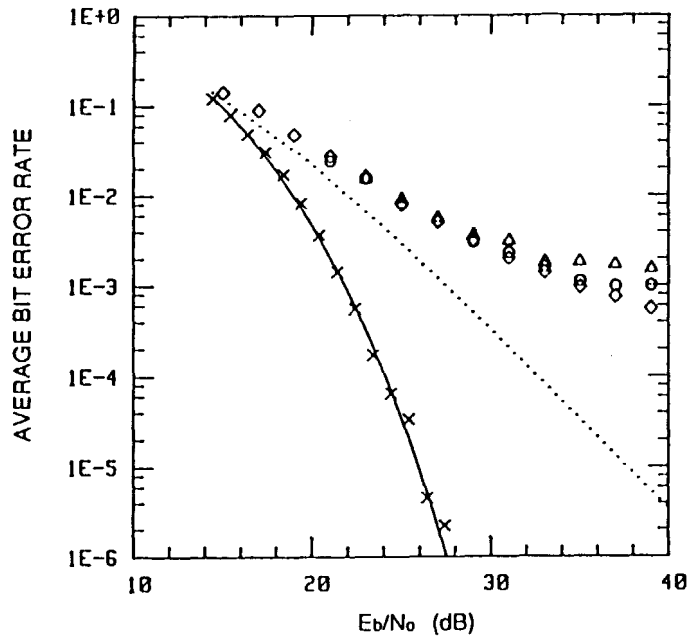



**FIG. 8 INDOOR TEST RESULTS FOR 19.2 kbps VOICE-BAND MODEM SIGNAL.**

A 19.2 kbps voice-band MODEM signal with 128 QAM was appraised, as a function of Eb/No, by bit error rates (BERs). The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity circuit. BERs were measured using both RF attenuators and Rayleigh fading simulators to simulate mobile radio environments. Crosses (×) denote the experimental results measured under the thermal noise. Diamonds (◇), circles (○), and triangles (△) represent the experimental results measured under fading frequencies of 5 Hz, 10 Hz, and 20 Hz, respectively. The solid line (——) denotes the optimal fit curve for the experimental data measured under thermal noise condition. The dotted line (·····) is theoretically estimated curve for diversity.